during cranium, head and neck, thorax and prostate imaging using PCXMC, a Monte Carlo computer program. The organ doses will be compared with published organ doses resulting from cone-beam CT and MV planar imaging.

**Materials and Methods:** The half-value layer, total filtration, radiation output and peak kilovoltage of the x-ray beams were measured using an Unfors Xi meter. Entrance dose, entrance field-size and focus to skin distance were calculated for each clinical protocol and used as input to PCXMC simulations. Clinically-representative beam directions and angles were used. Absorbed dose to each simulated organ and effective dose were calculated from a pair of ExacTrac exposures for each anatomical protocol.

**Results:** The maximum organ dose was 0.4 mGy to the kidneys from the prostate protocol. The maximum effective dose of 0.1 mSv was also from the prostate protocol. The maximum organ dose from a pair of ExacTrac images is between 27 and 128 times lower than published organ doses resulting from a single cone-beam computed tomography scan, and 250 times lower than doses from a single MV planar-imaging procedure published in the literature.

**Conclusions:** This study has shown that PCXMC can be used to estimate organ and effective doses from ExacTrac use. Organ doses from ExacTrac are low compared with those from cone-beam CT and MV planar-imaging.

**EP-1539**

**The dosimetric effect of a metal artifact reduction algorithm for head and neck RapidArc treatments**

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**Purpose/Objective:** The presence of dental implants or fillings affects the image quality of the planning-CT (pCT) of head and neck (H&N) patients by causing scatter and beam hardening artifacts. These artifacts can cause inaccuracies in the dose calculation of the radiation therapy treatment plan, in particular if a deterministic dose calculation algorithm is used (Acuros XB [AXB; Varian Medical Systems Inc., Palo Alto, USA]).

A recent commercially released CT reconstruction algorithm (MAR; General Electric, Milwaukee, USA) greatly reduces metal artifacts and thus hypothetically improves the accuracy of the dose calculation for patients with dental fillings or implants.

Applying a density override (DO) for the scatter regions is another often used solution to reduce the influence of metal artifacts on the dose calculation. We studied the effect of density overrides, the use of MAR and the combination of both on the dose distribution for H&N cancer patients with dental fillings treated with RapidArc (RA) radiotherapy.

**Materials and Methods:** For five H&N cancer patients with dental implants and/or fillings near the location of the tumor an additional MAR-CT reconstruction was acquired after the pCT was obtained. For each patient 4 different datasets were generated: 1)pCT without DO; 2)pCT with DO; 3)MAR-CT without DO; 4)MAR-CT with DO. Dataset 4 was used as the reference dataset. For each dataset a treatment plan was created using our standard clinical optimization protocol and calculated on the reference dataset using AXB.

For all plans DVH parameters ($D_{max}$, $D_{mean}$, $D_{2\%}$, $D_{98\%}$ and the $V_{95\%}$) for $PTV_{boost}$ and $PTV_{scatter}$, which represents only that part of the $PTV_{boost}$ which is affected by scatter, were reported and compared to those of the reference dataset. Also, differences in dose to the OAR, the ipsi- and contra-lateral parotid gland and the contra-lateral submandibular gland were reported in terms of $D_{max}$, $D_{mean}$ and $D_{2\%}$.

**Results:** Preliminary results for 1 patient show limited differences in PTV coverage between the 3 datasets and the reference dataset. The $D_{max}$ of the $PTV_{boost}$ differed 1% at most, and the $PTV_{scatter}$ shows an increase in $D_{max}$ of 1.4% for the treatment plan based on the pCT without DO (Table 1, Figure 1). Larger differences were found for the OAR's. The $D_{mean}$ of the contralateral submandibular gland was found to be 47 cGy, 90 cGy and 170 cGy higher for dataset 3, 1 and 2 respectively.

| | $PTV_{boost}$ | $PTV_{scatter}$ | $OAR_{parotid\ ri}$ | $OAR_{parotid\ le}$ | $OAR_{subman\ le}$ |
|---|---|---|---|---|---|
| $D_{max\ (cGY)(\%)}$ | 7888 (0,4) | 7851 (1,4) | 7599 (2,7) | 6175 (1,9) | 6201 (2,2) |
| $D_{mean\ (cGY)(\%)}$ | 7269 (1,0) | 7281 (1,2) | 3926 (2,1) | 2469 (0,3) | 3456 (2,7) |
| $D_{2\%\ (cGY)(\%)}$ | 7625 (1,0) | 7612 (1,2) | 7268 (1,6) | 5655 (0,7) | 5887 (1,1) |
| $D_{98\%\ (cGY)(\%)}$ | 6506 (0,6) | 6818 (1,1) | | | |
| $V_{95\%\ (\%)}$ | 97,4 (0,4) | 99,3 (0,4) | | | |

Table 1: Dose information pCT without DO and percentage difference compared to MAR-CT with DO

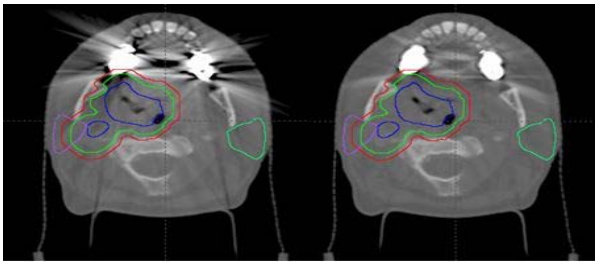

Figure 1: Planning-CT (left) and MAR-CT reconstruction (right) visualized with the contoured GTV (blue) , $CTV_{boost}$ (green) and $PTV_{boost}$ (red) , and both parotid glands (purple and lime).

**Conclusions:** Although there is an increase in mean dose of the OAR's when MAR, a density override or a combination of both is omitted, the differences in dose distribution between the several methods are small and not clinically relevant.

**EP-1540**

**Validation of ARTFiBio registation software. Comparative with comercial software and shared datasets**

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**Purpose/Objective:** The objective of the ARTFiBio project is to establish an integrated information network from which they can develop predictive models of tumour response based on functional data in vivo and to share datasets, and registration and predictive tools with the scientific community.

In order to relate information from multiple imaging modalities ( PET, CT y MRI) at different stages of treatment (through time) a robust registration scheme is critical. We present results of a comparison ARTFIBio tools with the

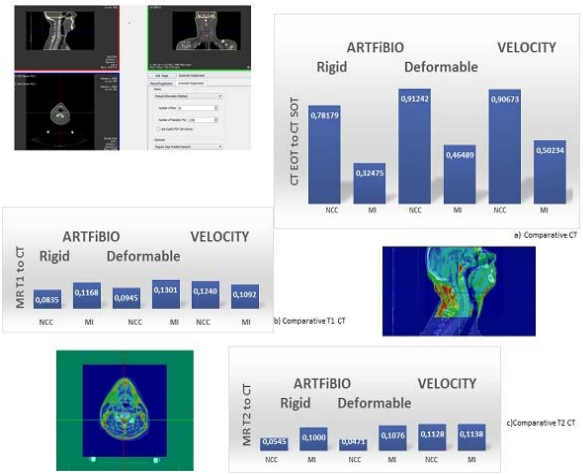
commercial software Velocity© to validate registration process.

**Materials and Methods:** We used 10 virtual phantoms from a website [1] for CT-CT deformable registration validation and 4 patients included in the project ARTFiBio [2] for validation of the CT-MRI registration.

The Velocity© registration was performed with the default B-Spline algorithm and the deformed images were exported to ARTFiBio software to calculate the metrics. Normalization Cross Correlation (NCC) and Mutual Information (MI) were implemented in the software ARTFiBio. To remove the Field of View dependence of the NCC, only voxels inside the external volume were used (restricted NCC).

ARTFiBio's registration tools are based on ITK libraries. For CT-CT registration bewere used recommended parameters in ITK documentation. For CT-MRI registration were used combination based on our own experience as users.

**Results:**




- CT – CT Registration: deformable registration shows best values for both metrics (NCC and MI) than rigid registration, as as expected. In the figure a), a comparison of ARTFIBio's tools with Velocity software is showed for CT-CT registration. Both softwares show similar metric values.

- CT – MRI registration: Velocity and ARTIFIBio tools get similar metric values for MI metric, but NCC metric can worsen comparing rigid to deformable registration, this is because NCC metric can not be applied for different imaging modalities.

**Conclusions:** In the ARTFIBio project different in-house free tools for registration has been implemented and are available by request for the scientific community. This software has been validated with commercial software, showing similar results. Real patients from the ARTFIBio database can be used for validating registration software using different imaging modalities (MRI and CT).

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References:

[1] J Pukala, SL Meeks, RJ Staton, et al , 'A virtual phantom library for the quantification of deformable image registration uncertainties in patients with cancers of the head and neck,' Medical Physics 40, 111703 (2013)

[2] M. Mera Iglesias, D. Aramburu, JL del Olmo, et al., 'Multimodality Functional Imaging in Radiation Therapy Planning: Relationships between Dynamic Contrast-Enhanced MRI, Diffusion-Weighted MRI, and 18F-FDG PET,' Computational and Mathematical Methods in Medicine, Article ID 103843, in press

**EP-1541**

**Identifying changes in the gross tumour volume after radiotherapy by image analysis**

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**Purpose/Objective:** In radiotherapy (RT) identifying changes in the gross tumour volume (GTV) between pre-treatment magnetic resonance (MR), computed tomography (CT) and follow-up CT images is challenging. This is because of anatomical deformations, change in the GTV in response to RT and soft tissue contrast variability between CT and MR. Here a new approach for registration and segmentation of the GTV on multi-modality data acquired before, during and after RT, is presented. The approach was tested on MR and CT image data from client owned dogs undergoing RT because of the similarities between canine and human cancers and the opportunity that this presents for fast-tracking RT improvements into clinical practice for both patient groups.

**Materials and Methods:** Image data from two veterinary patients (P1 and P2) with nasal adenocarcinoma treated at the University of Wisconsin, School of Veterinary Medicine was used. P1: pre-treatment T1-weighted MR and CT; CT after 6 and 12 weeks. P2: pre-treatment T1-weighted MR and CT; CT after 12 weeks. General Electric (GE Medical Systems, Milwaukee, WI, USA) Genesis and Signa scanners were used to acquire CT and MR data respectively and the GTV was identified on all images by an experienced veterinary oncologist. The algorithm developed uses a scale invariant feature transform (SIFT)-based rigid registration algorithm and a B-spline based non-rigid registration algorithm to register pre- and post-treatment images. The registration result is next used as a prior in a gradient-based level set (LS) method for segmentation of the GTV on post-treatment images.

**Results:** The performance of the rigid registration algorithm was first established by rotating $\Omega=(\pm 90^{\circ})$ and translating ($T_x$, $T_y$)=(±40% of image size) CT and MR images from the same patient. The sum-of-squares difference (SSD) of the image intensity data and the SIFT feature points were compared to the MI of the image intensity data and the new approach proposed, MI of SIFT. A match was defined when the clinical GTV contours and surrounding anatomical structures attained